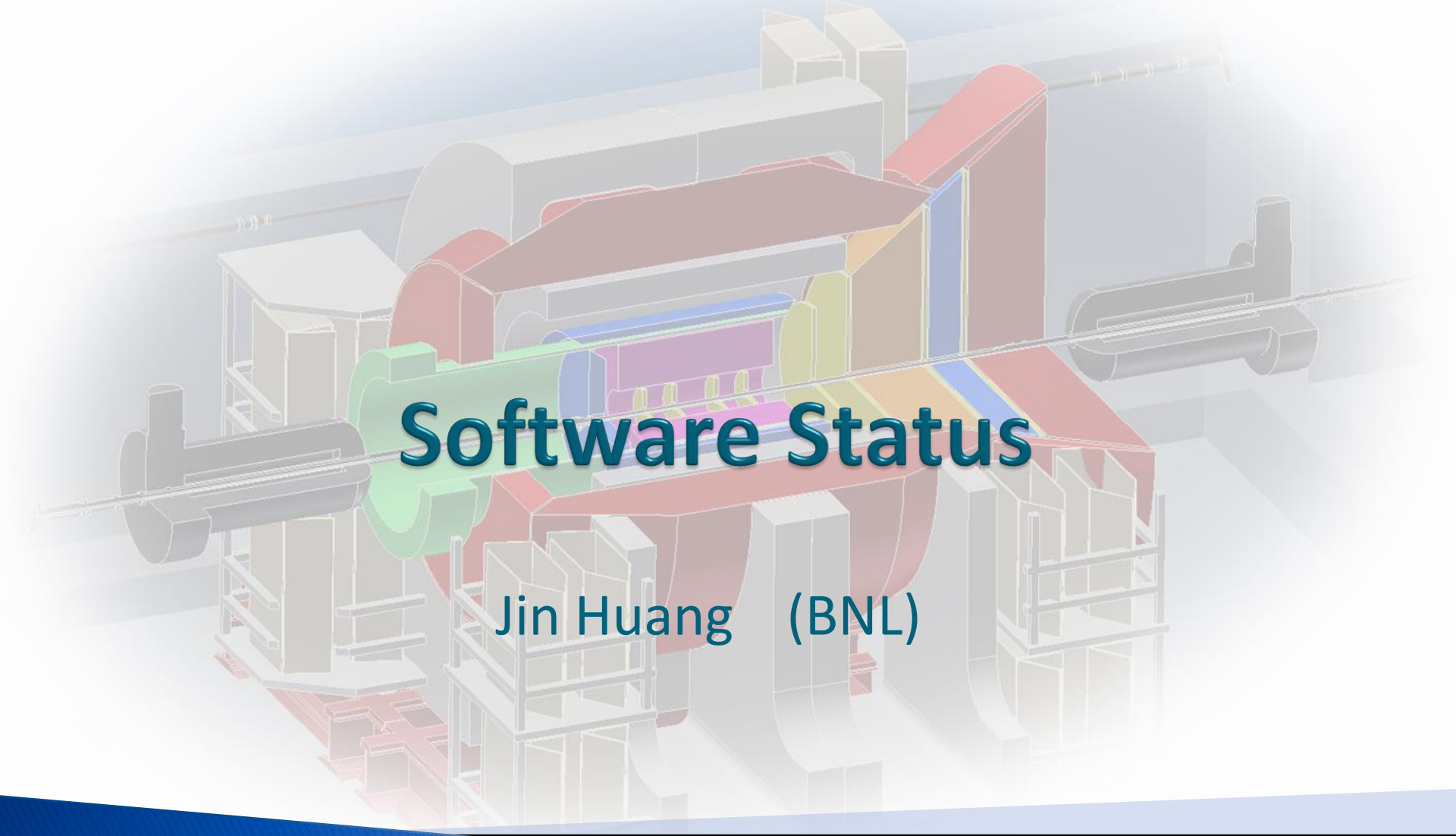

# Software Status

Jin Huang (BNL)

# Simulation framework

- Based on PHENIX software framework, a.k.a. Fun4All
  - Naturally supports pause analysis at any reconstruction stage (e.g. simulation/reconstruction/analysis or any sub steps), store intermediate data to file (a.k.a. DST file or PHENIX formatted ROOT file), and resume in another Fun4All reconstruction cycle
  - Naturally supports embedding, e.g. single particle in to A+A or Pythia8 p+p jet into A+A
  - Naturally supports event filtering, e.g. trigger on generator (e.g. **PHPy8JetTrigger**) or reco level (easy to write when needed)
  - Event mixing via analysis code
  - During event processing, reco data available in memory (**PHCompositeNode** ) for user to write a module to analyze on-the-fly or choose to save relevant parts to user-defined NTuple
- Constructs detector in Geant4 via C++. No automated interface to engineering drawing. Expert built and maintained.
- Calls Geant4 track input primary particles, Record digested Geant4 hits
- Truth ancestry tracing tool throughout analysis chain
- Common macro run the simulation and standard analysis chain
- Maintainer: Chris Pinkenburg, Mike McCumber, Jin Huang

# Event generator

- Reads all HEPMC format:
  - Fun4AllHepMCInputManager -> HepMCNodeReader
- Generator
  - Pythia8 for p+p: PHPythia8
  - Hijing for p+A, A+A
    - option for after-burner of flow: **flowAfterburner**
  - Some home-brewed format of EIC Pythia6 input: **ReadEICFiles**
  - Some support on YaJEM and JEWEL (Dave?)

# Fast simulation

- Available:
  - In core-software: event generator-based fast jet reconstruction via FastJet
  - In user analysis code: fast tracking/PID performance smearing
- On-going
  - Fast calorimeter simulation in core-software

# Tracking in Geant4

- Ready:
  - Cylinder shaped silicon tracker available
  - TPC + afterburner digitization
  - Ganging readout strips
  - Non-perfect channel aliveness
- Standard design options in standard macro: https://github.com/sPHENIX-Collaboration/macros/tree/master/macros/g4simulations
  1. Default: PHENIX VTX + RIKEN new strip layers in MIE: G4_Svtx.C
  2. PHENIX VTX + new TPC: G4_Svtx_pixels+tpc.C
  3. Maps inner pixel + RIKEN new strip layers: G4_Svtx_maps+strips.C
  4. Maps inner pixel + TPC: G4_Svtx_maps+tpc.C
  5. Full Maps (variation of ITS): G4_Svtx_ITS.C
- In development
  - Ladder based silicon tracker geometry
- Maintainer: Mike McCumber, Tony Frawley, Alan Dion (leaving)

# Tracking reconstruction

- Ready
  - Hough transform based helical pattern reco based on cylinder tracker
  - Some fake rejection
  - Home-brewd Kalman filter based on cylinder tracker
- Next step:
  - Generic Kalman filter
  - Handle ladder in silicon tracker options
  - Better handle of fake rejection
- Maintainer: Mike McCumber, Tony Frawley, Alan Dion (leaving)

# Calorimetry in Geant4

- Ready
  - Detailed EM calorimeter sim based on UCLA SPACAL prototype and current sPHENIX engineering design of enclusure
  - Detailed Hadron calorimeter based current sPHENIX engineering design
  - Tower scheme with geometry description
- Next step:
  - Details: light collection, variation, hadron interaction model
  - Calibration
- Maintainer: Chris Pinkenburg, Jin Huang

# Calorimetry reconstruction

- Clusterizer
  - Ready: a toy graph Clusterizer that connect all neighboring non-zero suppressed towers
  - Questionable support: PHENIX Clusterizer code
  - Missing: realistic Clusterizer that support non-spherical shower
- Track – calorimeter association
  - Track projection based Clusterizer
  - Likelihood macro tool for electron ID. Need to formulate a compiled module
- Maintainer: Mike McCumber, Jin Huang

# Jet tools

- Baseline jet reco (JetReco)
  - Input: truth, track, tower, cluster
  - Algorithm: FastJet, AntikT, etc.
  - Output: Jet with truth association
- Exploratory:
  - CMS style flow jet: **PHFlowJetMaker**
- Need
  - Background subtraction (coded in PHENIX software, need to be migrate over to sPHENIX and improve code standard)
  - Fake rejection, some quick form in PHENIX code base. Need to improve/port over to sPHENIX
  - B-jet tagging (only in form of fast truth sim, not in reco)
- Maintainer: Mike McCumber, Jin Huang

# Simulation production

- Standard set with full detector Geant4 information stored
  - 1000 particle per setting
  - X 4 eta bin
  - X 10 momentum bins
  - X 9 particle species
  - Reproducible in 1 day
- Standard Hijing set with full detector information stored
  - 1000 event per setting
  - b = 0-4fm, b ~ 8fm
  - Reproducible in 1 day
- On demand production sets
  - 100k single particle per setting for resolution tail study
  - Tracking only Hijing->G4 simulation with 10k(?) level event
  - Rare event -> Hijing embedding in full detector by reusing the same 1000 Hijing full detector simulation
- Computing facility:
  - RACF @ BNL: 10k CPU for single particle simulation, 2k CPU for Hijing related simulation, 200 TB(?) disk
  - Possible future for OpenScienceGrid
- Time cost:
  - Geant4: ~1s / single particle, ~15min / Hijing event
  - Reconstruction: ~1s / embedded Au+Au event
- Maintainer: Chris Pinkenburg

# MISC

- What is the mode of interaction between physics/analysis, simulation and detector specialists?
  - Most via Tue software meeting and private meetings
- Need some documentation site.
  - Right now via sPHENIX wiki: https://wiki.bnl.gov/sPHENIX/index.php/Software
  - Options for Twiki?